DEPARTMENT OF THE NAVY
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
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SPAWAR 052
05 Nov 2003

SPAWAR INSTRUCTION 3090.1

From: Commander, Space and Naval Warfare Systems Command

Subj: C4ISR SYSTEM CRITERIA FOR SHIPBOARD TOPSIDE INTEGRATION

Ref: (a) SPAWARINST 4200.26B
(b) SPAWARINST 2450.1
(c) OPNAVINST 5100.23F
(d) OPNAVINST 5100.19D
(e) OPNAVINST 9070.2

Encl: (1) C4ISR Topside Design Points of Contact
(2) C4ISR Topside Design and Integration Criteria

1. Purpose. To provide guidance to PEOs, PMs and SPAWAR for Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR) systems surface ship topside design as required by references (a) through (e).

2. Information. Enclosure (1) provides a list of personnel who can address specific design areas for program managers. Enclosure (2) provides the list of topside design requirements and the basis for those requirements as guidance to program managers.

3. Scope. Program managers shall include pertinent design requirements in acquisition documentation to ensure equipment and systems will meet their mission requirements within program cost and schedule constraints. Program managers shall provide the necessary engineering support to ensure that design planning, execution and verification are performed by equipment and system developers. A temporary Integrated Product Team (IPT) may be formed by the program manager to coordinate the various technical and program planning of complex systems that require significant coordination among various groups or agencies.

a. Reference (a) includes relevant design requirements to ensure systems meet their mission performance requirements.

b. Reference (b) is to ensure systems are not degraded by electromagnetic interference, will not degrade other co-located or nearby systems, and to ensure that the frequency spectrum is managed for maximum compatibility with own force and international systems.

c. References (c) and (d) require that program managers include safety as a consideration in the design of afloat systems.

d. Reference (e) requires that program managers include signature control for topside systems in order to ensure total ship signature requirements are met.

4. Points of Contact. Questions regarding this instruction should be addressed to Mr. Mike Stewart, SPAWAR 052, (619) 524-7230, fred.stewart@navy.mil or to Mr. David Southworth, SSCSD Code 2856, (619) 553-3248, dave.southworth@navy.mil.

/s/
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Distribution:
SPAWAR List 3, (04, 05, 07, PEOs, PDs and PMWs only)

C4ISR SYSTEM CRITERIA FOR SHIPBOARD TOPSIDE INTEGRATION

Office of Chief Engineer
Architecture and Standards

SPAWAR 052

April 21, 2003

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Note POCs are subject to change and will be incorporated in later versions of this document

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C4ISR TOPSIDE DESIGN AND INTEGRATION CRITERIA

Forward

To minimize development costs and schedule while integrating new equipment into the fleet, the program manager must deal with the impact of the mechanical, climatic, environmental, signature and electromagnetic environmental effects upon equipment, systems, and associated surface ship platforms.

This document may be used as a top-level summary of the key design and integration requirements for equipments/systems installed topside on Naval ships. The design requirements discussed herein should be completed prior to the start of the D-30 ship alteration schedule. The installation schedules will dictate the time available to perform a topside integration, thus the need to start early. EMI Certification is one of the activities that occur after installation of the shipboard equipment.

This guidance document is not meant to replace or modify the direction or authority contained in formally issued directives and standards.

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1 EME/EMC

1.1 Spectrum Certification (Spectrum Management)

Ref: (a) U.S. Department of Commerce, National Telecommunications and Information Administration (NTIA), Manual of Regulations and Procedures for Federal Radio Frequency Management of Jan 00
(b) DoD Directive 4650.1, Management and Use of the Radio Frequency Spectrum of 24 Jun 87
(c) DoD Directive 5000.1 - Defense Acquisition
(d) DoD Directive 5000.2 - Defense Acquisition Management Policies and Procedures
(e) Naval Telecommunications Publication (NTP)-6 (D) of 31 Aug 92
(f) OPNAVINST 2400.20E, Navy Management of the Radio Frequency Spectrum of 08 Jan 90
(g) SPAWAR Instruction 2450.1 of 12 Nov 91

1.1.1 Overview: All equipment having the ability to radiate or receive electromagnetic energy using a specific frequency or band of frequencies must have been spectrum certified for operations within that band by the National Telecommunications and Information Administration (NTIA). The electromagnetic spectrum is a finite resource and has many users within the Federal government, and civil areas. In addition all nations have their own rules and regulations for the use of the electromagnetic spectrum, and within the confines of international law have sovereignty on how that resource is used within their borders. For orderly use of the spectrum, international agreements have divided the usable spectrum into various bands designated for specific services. The worldwide division of the electromagnetic spectrum is coordinated by the International Telecommunications Union (ITU); the United States is a member of this Union.

a. The United States NTIA represents U.S. Federal government interests as they pertain to the use of the electromagnetic spectrum within United States and its Possessions (US&P). The Federal Communication Commission (FCC) coordinates the use of the electromagnetic spectrum for the commercial sector. Working hand-in-hand, these two agencies coordinate the use of the electromagnetic spectrum, within US&P, as shared Government/Non-Government use spectrum.

1.1.2 Process: For military systems used within the US&P, the DD Form 1494, Spectrum Allocation Application (J/F 12), must be completed per reference (a) to indicate that a system being procured will operate in a specific frequency band with a specific set of operating emission characteristics. The submittal of a J/F 12 will result in Spectrum Certification by the Office of Spectrum Management of the NTIA. The J/F 12 initial application and any renewal should be coordinated with SPAWAR 051-1. There are four stages in the certification process; Conceptual, Experimental, Developmental, and Operational.

a. A stage 1 (conceptual) spectrum certification must be completed during Milestone A in the acquisition process to allow an NTIA review of the system's intended emission characteristics. The stage 1 J/F 12 will document the intended frequency band or bands, what the equipment is to be used for, provide proposed system characteristics such as power and bandwidth, and to obtain guidance from the NTIA via the Military Communications Electronics Board (MCEB) on use of the proposed band. A stage one certification is advisable prior to obligating funds for studies or proof of concept type test beds.

b. A stage 2 (experimental) spectrum certification is required prior to release of funds for building a radiating test model or the assignment of a radio frequency for experimental usage. The "experimental" DD 1494 should have data close to what the actual fielded system is capable of achieving. The form should have adequate information to support E3 and topside data requirements.

c. A stage 3 (developmental) spectrum certification is required as a part of Milestone B, prior to release of funds for engineering developmental models or assignment of radio frequencies for developmental usage. Stage 3 Spectrum Certification, by the NTIA, authorizes the requesting and subsequent assignment of frequencies for field testing of the system.

d. A stage 4 (operational) spectrum certification is required in Milestone C, prior to release of funds for production units. The program office submits this application for approval by NTIA prior to the production, fielding/deployment and operational support of the desired system. Stage 4 Spectrum Certification identifies the system as being fully certified for use within US&P. Upon receipt of stage four certification, the user may request, but is not guaranteed, a permanent and protected radio frequency assignment. Although the stage four certification is the final stage in the certification process, systems must be continually monitored to ensure any and all emission characteristic type changes are accurately reflected in existing versions of the Spectrum Certification document.

e. The Spectrum Certification process accomplishes a variety of extremely important items. As the system progresses through the certification process beginning with stage one, there can be no ambiguity on whether the system will operate within the parameters listed within the NTIA manual. The system's emission characteristics are entered into the Spectrum Certification System (SCS) Database, this database is used by the Frequency Assignment Community at the NTIA and DoD System Commands level in their attempt to de-conflict frequency assignments within US&P. This same database is used by U.S. Joint Frequency Management Offices worldwide to coordinate and assign frequencies with the international community. The Joint Spectrum Center uses this database for a variety of spectrum related tasks in support of the Radio Frequency Spectrum Community around the world.

f. The Spectrum Certification process also provides a means by which foreign coordination may be accomplished. Typically foreign coordination does not begin until stage three, at which time along with stage three applications, the program office will request that foreign coordination be accomplished. As the number of spectrum aware countries increases so does the importance of foreign coordination. The foreign coordination process requires that a system's "releasable" emission characteristics be forwarded via the MCEB to foreign countries for coordination and approval for use. Systems may be generally approved for use internationally; this approval does not negate the need for a frequency request, submitted by the user, nor does it guarantee a frequency assignment. It is up to the host government to determine whether frequencies are available for use by a system in a specific area at a specific point in time. In foreign countries all frequencies are coordinated with the host government and the user submits a frequency request via the appropriate chain of command to initiate this coordination.

Note: Electromagnetic signals do not recognize international boundaries. Care must be taken when operating within the air space or territorial waters of a foreign country to ensure that system emissions are not causing damage ashore by interfering with systems operating in the same frequencies or frequency band. Failure to take such considerations into account has, in the past, prevented use of critical military systems within areas in which they were designed to operate.

1.2 Topside Equipment/System EMI

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-HDBK-237C, Electromagnetic Compatibility Management Guide for Platforms, Systems, and Equipment of 17 Jul 01
(d) MIL-STD-461E, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment of 20 Aug 99
(e) JSC-CR-99-060, Measurement Procedures for Estimating COSAM Parameters of Sep 99
(f) MIL-STD-469, Interface Standard: Radar Engineering Design Requirements, Electromagnetic Compatibility
(g) NTIA-Report 84-157, Measurement Procedures for the Radar Spectrum Engineering Criteria, of Aug 84

1.2.1 Overview: Equipment and/or system level EMI analysis and/or testing is typically included as part of the system acquisition, included in acquisition documentation, to meet the direction of references (a) and (b), using the guidance of reference (c).

1.2.2 Process: The Equipment/System EMI design and verification testing is often a collaboration effort between the equipment/system vendor and the Government. A report, defining equipment test configurations and test results to tailored versions of references (d) through (f), should be part of the deliverable items from the field activity or contractor. The report(s) could be drafted by the Government or the contractor, whichever is considered lead or providing the most EMI experience to the effort or specifically contracted to perform and document the results. The EMI report will define the MIL-STD-461 or equivalent susceptibility and emission parameters that are both radiated and conducted for the system and co-located systems. The radio or radar test performance reports will provide the references (e) through (g), performance data (for instance near and far field antenna patterns). This test data will assist in indicating whether the equipment/systems are a potential source and/or victim of interference, which leads the way to a solution.

Note: For AEGIS installations, the test plans and testing require review by NSWCDD (J54).

1.3 EMC (Topside Analysis)

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) JSC-CR-99-060, Measurement Procedures for Estimating COSAM Parameters of Sep 99
(d) MIL-STD-469, Interface Standard: Radar Engineering Design Requirements, Electromagnetic Compatibility

1.3.1 Overview: Ship Program Managers (SPM) have the responsibility, as identified in references (a) and (b), to determine topside installation locations based upon the analysis and technical advice provided by a topside design activity (either a field activity or a contractor). An electromagnetic environment analysis for integrated topside design is performed to ensure that the equipment will function properly during exposure to the fleet electromagnetic environment (EME). The fleet EME is a requirement that needs to be established in the acquisition phase with SPAWAR 051-1 assistance. Analytical tools are used to determine if interference exists from a variety of spatial, frequency, blockage, coverage and amplitude parameters. (The measurement of system response in the desired EME can be part of the acquisition. The topside design is usually done as part of system installation, after the acquisition.)

1.3.2 Process: The topside design must accomplish the objective of preserving the required system performance and minimizing interference to surrounding systems. This is done through optical blockage modeling (taking into account ships motion), RF coupling analysis and antenna pattern perturbation due to nearby structure and finally a system performance analysis. The design of the system may be impacted by the need for filters, tighter receiver characteristics, better signal processing techniques, multiple antennas, handover switching and other engineering challenges.

EMC at the design level is best achieved by the Program Manager (PM) obtaining the correct EME from topside design activities. A resource for the PM to contact SPAWAR Topside engineering expertise is the Topside IPT chaired by 051-1C. To meet the E3 requirements of references (a) and (b), radio or radar test performance reports, per references (c) and (d), are procured to provide the performance data that will be used in the analytical calculations described above.

Ultimately, the Ship Program Manager (SPM) determines topside locations based upon the recommendations of their field activities, who perform much of the topside analysis.

1.4 Electromagnetic Environment (EME) (MIL-STD-464)

1.4.1 Electromagnetic Vulnerability (EMV)

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-STD-464 Electromagnetic Environmental Effects for Systems

1.4.1.1 Overview: The operability and survivability of C4ISR systems within the fleet intense EME is required to ensure operational performance to meet the direction of references (a) and (b) and the tailored requirements of reference (c).

1.4.1.2 Process: The design is reviewed for adequate shielding, bonding, grounding and filtering to determine if system electronic command and control systems will meet performance requirements when exposed to the electromagnetic environment of nearby high power radar and radios from host-platforms emitter systems and nearby emitter systems. The appropriate EME tables of reference (c) shall be used as a default EME if one is not specifically generated for the expected operational scenarios of the equipment and systems. This EME shall be coordinated with SPAWAR 051-1.

1.4.2 TEMPEST

Ref: (a) SECNAVINST 5239.3, Department of the Navy Information Systems Security (INFOSEC) Program of 14 Jul 95
(b) NSTISSD No. 502, National Security Telecommunications and Automated Information Security of 5 Feb 93

1.4.2.1 Overview: TEMPEST is handled at the equipment level by SSC-Charleston to verify the design and installation will meet the direction of reference (a). TEMPEST is an unclassified name for the engineering design and verification process of controlling compromising emanations.

1.4.2.2 Process: The equipment undergoes TEMPEST testing or analysis to determine if it meets the requirements defined in references (a) and (b).

1.4.3 DC Magnetic Field

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-STD-464 Electromagnetic Environmental Effects for Systems
(d) MIL-STD-1399-070, Interface Standard for Shipboard Systems, D.C. Magnetic Field Environment of 26 Feb 79

1.4.3.1 Overview: The operability of C4ISR systems within the ship's DC magnetic fields, such as generated by the degaussing system, shall be determined so as to meet the direction of references (a) and (b) and the specific field requirements of references (c) and (d). This requirement may not be necessary for mast-mounted topside equipment. Associated systems located below the weather deck must meet the requirement.

1.4.3.2 Process: The requirement shall be imposed in acquisition documentation for topside systems that have ferro-magnetic equipment (i.e. gyros, compass, etc.) and are located near sources of high magnetic fields (usually not the case for mast mounted systems) and shall be verified by testing per references (c) and (d).

1.4.4 Electrical Power Characteristics

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-STD-1399, Section 300A, Interface Standard for Shipboard Systems, Electrical Power, Alternating Current
(d) MIL-STD-464 Electromagnetic Environmental Effects for Systems
(e) MIL-STD-1310G, Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety of 28 Jun 96

1.4.4.1 Overview: The operability of C4ISR topside equipment and systems while connected to the shipboard power system shall be verified to meet the direction and requirements of references (a) through (d). The shipboard grounding and bonding of electrical systems shall meet the requirements of reference (e) for EMC and shock hazard reduction.

1.4.4.2 Process: Appropriate requirements from references (c) through (e) shall be imposed in acquisition documentation for C4ISR equipment and then verified by inspection, analysis and test.

1.4.5 Lightning

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-STD-464 Electromagnetic Environmental Effects Requirements for Systems of 18 Mar 97

1.4.5.1 Overview: The system shall meet its operational performance requirements for both direct and indirect effects of lightning. Antenna systems should provide for diversion of direct strike currents and associated receiver/transmitter equipment should not be damaged by direct strikes. Antenna systems should remain operational when exposed to nearby strike electromagnetic fields. The safety and operability of C4ISR systems shall be verified to meet the direction of references (a) and (b) and requirements of reference (c).

1.4.5.2 Process: The lightning requirements that shall be delineated in acquisition documentation and verified by test or analysis are identified in paragraph 5.4 of MIL-STD-464. Figure 1 shall be used for the direct effects lightning environment. Figure 2 and Table IIA of MIL-STD-464 shall be used for the indirect effects lightning environment from a nearby strike. Table IIB of MIL-STD-464 shall be used for the near lightning strike environment.

a. Compliance shall be verified by system, subsystem, equipment, and component (such as structural coupons and radomes) level tests, analysis, or a combination thereof using the guidance of MIL-STD-464. (Note: full threat lightning survivability testing of systems is difficult so testing is usually limited to model or coupon testing.)

1.4.6 Electromagnetic Pulse (EMP)

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) MIL-STD-464 Electromagnetic Environmental Effects Requirements for Systems of 18 Mar 97
(d) MIL-STD-461E, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment of 20 Aug 99
(e) MIL-STD-2169B, High Altitude Electromagnetic Pulse
(f) MIL-STD-1310G, Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety of 28 Jun 96

1.4.6.1 Overview: In accordance with the direction of references (a) and (b) and requirements of references (c) and (d), the system shall meet its operational performance requirements after being subjected to the EMP environment of reference (e). All DDG-51 and CG-47 class ships and Underway Replenishment Station Ships require EMP protection conduit installation for all topside equipment in accordance with MIL-STD-1310. Also there are PMS 400 requirements governing the type of cable to be used as well. The ship specification, sometimes covered in Section 407, will indicate what environment or HEMP requirement has been imposed on the ship, which the system must meet.

1.4.6.2 Process: If an EMP environment is not defined by the procuring activity, Test Methods CS116 and RS105 from MIL-STD-461E or paragraph 5.5 from MIL-STD-464 shall be used for equipment or systems, respectively. This requirement is not applicable unless otherwise specified by the procuring activity. Compliance shall be verified by equipment, subsystem, and system level tests, analysis or a combination thereof.

a. Testing at the equipment and subsystem level shall be in accordance with the test configuration as identified in MIL-STD-461E. The test report shall be a deliverable to the Government in accordance with the requirements of Data Item Description DI-EMCS-80200B, Electromagnetic Interference Test Report (EMITR).

b. System level EMP analysis or testing shall be accomplished in accordance with MIL-STD-464 and a contractor format report submitted to the Government. There presently is no national test capability to do system level free field full threat EMP testing at sea with the system installed on the ship. System and equipment level testing can be performed with the system or equipment placed in a bounded wave EMP simulator or set-up on an outdoor ground plane EMP facility.

c. An approach to determining necessary EMP hardening of a new system, used by SSC-SD, is a combination of numerical computation and Bounded-wave EMP modeling using the brass ship models. The software provides the initial design response and protection scheme, which is then verified using the brass ship model. The brass ship model is placed within the Bounded-wave EMP simulator that provides an imitation of a vertically polarized plane wave incident upon the brass model. Since the HF antennas and components of other systems are vertically polarized and have low-elevation main lobe patterns at frequencies corresponding to high energy levels in the EMP spectrum, this testing provides for a worst-case vulnerability analysis, as well as verifies the computational accuracy. (This technique using scaled models (i.e. SSC-SD brass ship models), subthreat illumination, and calculations provides hardening design information. To verify the hardness of the system as built and installed, the following should be considered. Direct injection of a calculated antenna response can verify a transient protection device is working (front door coupling). Further, if the system design calls for shielding and gasketing then direct illumination or current injection of the system will be required to verify overall system performance (back door coupling effects).

1.4.7 EMI Certification (EMI Survey, Fix, Tracking Documentation)

Ref: (a) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(b) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(c) NAVSEA S9040-AA-GTP-010/SSCR, Shipboard Systems Certification Requirements for Surface Ship Industrial Periods (Non-Nuclear),Revision 4, 01 June 1998
(d) MIL-STD-1605, Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships of 20 Apr 73

1.4.7.1 Overview: EMI Certification was implemented by Reference (c) to ensure newly constructed ships or modified ships emerge in the optimum EMC condition. Proper equipment and system EMC design can minimize fixes that will be required to pass the EMI Certification. Appropriately trained personnel perform the test program. The Shipboard EMI Improvement Program (SEMCIP), funded by NAVSEA and operated primarily out of NSWCDD, provides the test program for new ships installations. System EMI Certification is performed on at least the first ship installation of a ship class. System EMI Certification provides discovery and certification of a newly installed or modified system that has RF impact to the topside of the ship.

1.4.7.2 Process: The test procedures are delineated in Reference (d). System EMI Certification and Ship EMI Certification requires planning, testing and reporting using the Shipboard EMI Improvement Program (SEMCIP) Technical Assistance Network (STAN) data and procedures, since STAN is the only authorized tool used for identifying known or probable EMI problems. STAN can be accessed on the Internet at https://www.stan-smits.com/navsea/. STAN is web based and can be accessed via the Internet when provided with a password authorized by NAVSEA 623. Note: the goals of SEMCIP are to rectify mission degrading EMI problems and maintain shipboard EMC.

1.4.7.3. Completion: The completion of the process is the Certification Letter sent to the ship that documents the resolution of any EMI problems and fixes for the installation upon the ship.

1.4.8 RADHAZ (HERP, HERF, HERO)
(HERP – Hazards of Electromagnetic Radiation to Personnel)
(HERF - Hazards of Electromagnetic Radiation to Fuel)
(HERO - Hazards of Electromagnetic Radiation to Ordnance)

Ref: (a) DODINST 6055.11, Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers of 21 Feb 95
(b) OPNAVINST 2450.2, Electromagnetic Compatibility Program within the Department of Navy of 3 Jan 90
(c) SPAWARINST 2450.1, Electromagnetic Environmental Effects (E3) within the Space and Naval Warfare Systems Command and Warfare Systems of the Battle Force of 12 Nov 91
(d) OPNAVINST 5100.19D, Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat of 5 Oct 2000
(e) OPNAVINST 5100.23E, Navy Occupational Safety and Health (NAVOSH) Program Manual of 5 Oct 2000
(f) MIL-STD-464 Electromagnetic Environmental Effects Requirements for Systems of 18 Mar 97
(g) NAVSEA S9040-AA-GTP-010/SSCR, Shipboard Systems Certification Requirements for Surface Ship Industrial Periods (Non-Nuclear),Revision 4, 01 June 1998

1.4.8.1 Overview: The system shall comply with current national criteria for the safety and protection of personnel, ordnance and fuel against the effects of electromagnetic radiation and meet the direction of references (a) through (g). DoD policy is currently found in reference (a).

1.4.8.2 Process: Compliance with appropriate RADHAZ requirements shall be verified by test in accordance with ref (g) following system installation. Quoted from reference (d):

a. Radio Frequency (RF) and Microwave Radiation. Radar and communications equipment (transmitters) and RF heat sealers may emit hazardous levels of RF/microwave radiation. In addition to causing biological changes, RF/microwave radiation can induce electrical currents/voltages that may cause shocks and burns, premature activation of electro-explosive devices (EEDs) in ordnance, and arcs, which may ignite flammable materials.

(1) Radar and Communications. Information on the hazards of electromagnetic radiation to personnel, fuels, and ordnance is available in Volume I for Hazards of Electromagnetic Radiation to Personnel (HERP) and Fuels (HERF) and Volume II for Ordnance (HERO) of NAVSEA OP 3565/NAVAIR 16-1-529/NAVELEX 0967-LP-624-6010. "Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel, and other Flammable Material)" (NOTAL). Per BUMEDINST 6470.22, Navy Radiological Systems Performance Evaluation Program, 18 April 2000, surveys are generally provided at the completion of acceptance trials or upon ship requests (e.g., following topside changes or changes to the ships RFR emitters). Surveys are performed to determine if the Permissible Exposure Limits (PELs) are exceeded in normally occupied areas, particularly with respect to the established guidelines identified in SECNAVINST 5100.14C. Military Exempt Lasers (NOTAL). Following a survey, a complete set of RADHAZ control measures (See appendix B9-A of OPNAVINST 5100.19D for description which may include keep out zones, radiation cutouts, and/or restrictions) is provided to mitigate RADHAZ and to obtain a NAVSEASYSCOM letter of certification. For information and technical assistance, contact NSWCDD (Code J52).

2 <u>Antenna Radar Cross Section (RCS)</u>

Ref: (a) OPNAVINST 9070.1, Survivability Policy for Surface Ships of the U.S. Navy of 22 Sep 88
(b) OPNAVINST 9070.2, Signature Control Policy for Ships and Craft of the U.S. Navy of 5 Dec 96

2.1 Overview: The RCS requirement applies to all ships with reduced Radar Cross Section. This requirement currently applies to ships of the following classes: FFG 7, DD 963, CG 47, DDG 51 Flt I, II and IIA, PC 14, LPD 17, and CVNX 2. It is also anticipated that JCC(X), LHA Replacement, and future ships will incorporate overall ship RCS requirements. Goals of signature control include:

a. Reducing overall detection and targeting of the ship or craft to a range less than the maximum effective range of its main defensive battery for air, surface, and undersea warfare;

b. Reducing the distinction between specific ship or ship class signatures, thereby preventing identification and targeting of specific ships or ship classes;

c. Reducing the likelihood that a homing weapon could acquire and guide onto a reduced-signature ship equipped with active and passive countermeasures; and

d. Blending passive signature reduction and active signature management measures (emissions control) to prevent exploitation and cause confusion in the enemy's ability to identify and target ships.

Signature control shall be considered a fundamental design requirement at the total ship systems level. Signature control features shall be incorporated in a cost-effective manner in all shipboard systems, machinery, communication and combat systems, shall be designed into all systems from inception, and shall be maintained through the ship's life cycle.

2.2 Process: An assessment of the RCS contribution by the installed antenna system shall be made by analysis and verified by testing to meet the policy requirements of reference (a). An outline of the process is provided below:

a. The SPAWAR Program Manager (PM) notifies NAVSEA 05T1 that a new topside system is planned.

b. NAVSEA 05T1 generates an RCS requirement for the new topside system and provides the requirement to the SPAWAR PM.

c. The SPAWAR PM incorporates the RCS requirement into the system specifications and proceeds with system procurement.

d. During the system design phase and prior to manufacturing, analytical modeling and predictions, and/or physical scale modeling and measurements, are recommended as part of an RCS risk reduction strategy.

e. After manufacturing of the first article, an RCS measurement is required to verify compliance with the requirements.

f. Upon successfully meeting the RCS requirements, NAVSEA 05T1 issues a letter stating that the topside system is RCS compliant.

Testing has typically been performed at NAWCWD/Point Mugu, or through NSWCCD using Naval Research Lab RTS software to predict the design response. NSWCCD antenna RCS engineers, using such facilities as the compact range at NAWCWD/Point Mugu, conduct RCS measurements. The SPAWAR PM provides funding required for NSWCCD test plan preparation, on-site coordination, data analysis, quick look presentation and final report.

3 **Dynamic Environments**

3.1 **Shock**

Ref: (a) OPNAVINST 9072.2, Shock Hardening of Surface Ships of 12 Jan 87
(b) NAVSEAINST 9072.1, Shock hardening of Surface Ships 11 Nov 89
(c) SPAWARINST 4200.26A, change 3, Procedures for Effective Acquisition of SPAWAR Systems Equipment and Support Services of 7 Feb 94
(d) SPAWARINST 4130.1A, SPAWAR Configuration Management Policy and Procedures of 22 Apr 88
(e) NAVSEAINST 9491.1C, Location of Approved Class HI Shock Testing Facilities of 21 Mar 96
(f) MIL-S-901D Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment and Systems, Requirements for of 17 Mar 89
(g) NAVSEA 0908_LP_3010 Shock Design Criteria for Surface Ships of May 76

3.1.1 Overview: All equipment intended for installation aboard Navy ships requires shock approval by Naval Surface Warfare Center Carderock Division (NSWCCD), Code 625, acting as NAVSEA's Designated Approval Authority (DAA) in accordance with references (a) and (b). The intent is to meet the direction of references (a) through (e).

3.1.2 Process: The SPAWAR Shock Coordinator, SPAWAR 051-1 or its representative, is designated as SPAWAR's representative to the DAA. The following procedure shall be adhered to in the shock approval process:

a. The SPAWAR procuring activity shall contact the SPAWAR Shock Coordinator as early as possible in the acquisition process to determine shock requirements.

b. The SPAWAR Shock Coordinator shall assist the procuring activity in preparation of a shock test plan for the equipment to be procured. If the test plan requires a heavyweight shock test or a lightweight or mediumweight test using non-standard fixtures, the test plan shall be submitted to the DAA for approval at least 60 days prior to the planned test date. Test plans involving lightweight and/or mediumweight shock tests using standard fixtures do not require prior approval by the DAA but submittal of test plans for approval is recommended in all cases when time permits.

c. For light weight and/or medium weight tests, the procuring activity shall conduct the required test series at SPAWARSYSCEN/SD or SPAWARSYSCEN/Charleston unless use of an alternate facility is deemed more advantageous. (Note: SPAWARSYSCEN/SD Code 2655 is the preferred test facility for mediumweight shock tests of SPAWAR equipment. SPAWARSYSCEN/SD 2655 and SPAWARSYSCEN/Charleston J326 are the preferred test facilities for lightweight shock tests of SPAWAR equipment.) Any alternate test facility must be listed as approved in reference (e). For heavyweight tests, the SPAWAR Shock Coordinator shall arrange with one of the approved heavyweight test facilities (as listed in reference (e)) to perform the test series. An appropriately trained Government witness shall monitor all shock test series and ensure that all necessary procedures are performed by the test facility and the procuring activity. A final report of the testing shall be provided to the procuring activity and the SPAWAR Shock Coordinator.

d. For mast mounted items, the shock environment should be defined by NSWCCD for the intended ship class. The test set-up shall be based on the defined test environment, and will dictate whether a lightweight, medium weight, or heavy weight test is required depending on the test fixture and environment.

e. Upon completion of the shock test series, a shock test report must be prepared. The report must be submitted to the DAA for approval and inclusion in the Navy Shock Data Base (NSDB), maintained by NSWCCD. The DAA will prepare Form 19 (Shock Test Acceptance Information) for includsion in the NSDB.

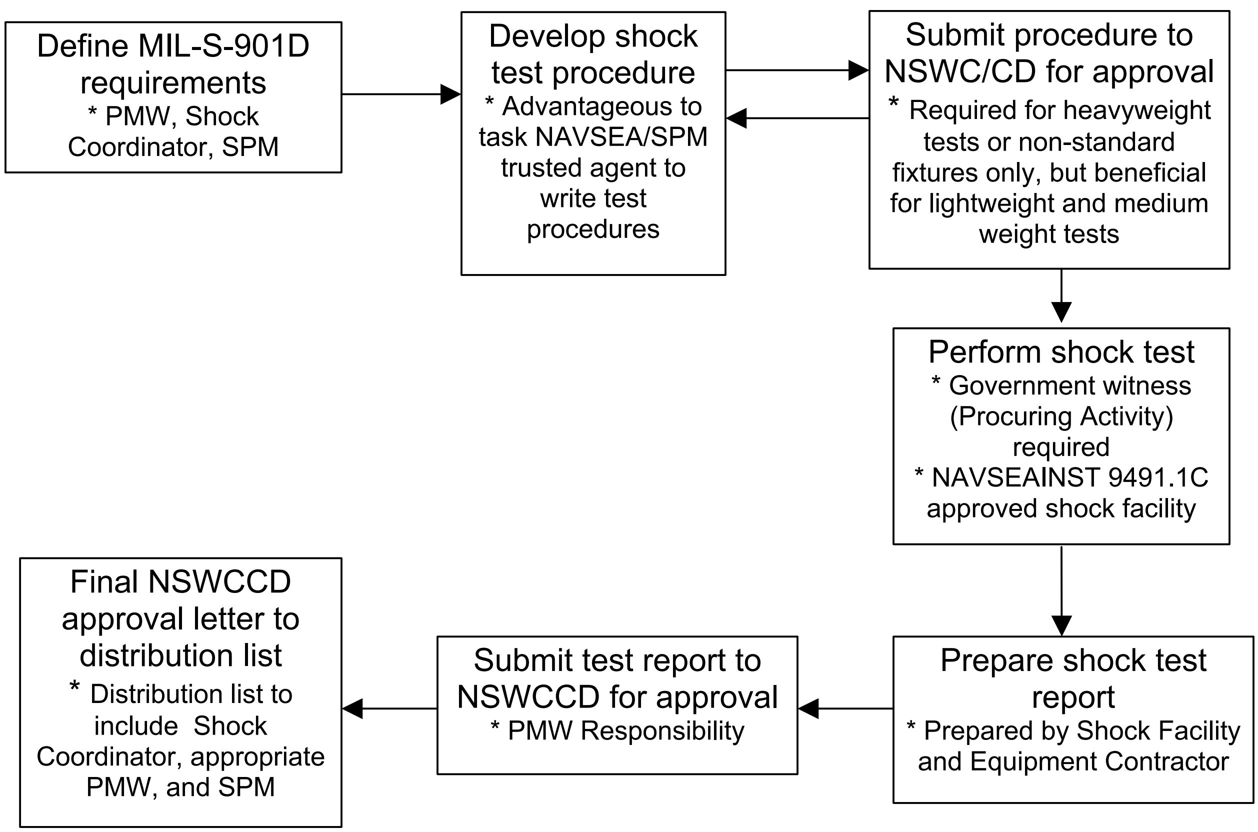
3.1.3 <u>Qualification by Extension</u>: When shock approval is required it is sometimes possible to satisfy the requirement on the basis of previously conducted shock tests on identical or similar items. Similarity may be used as a basis for extension from a previously shock tested item. Approval based on a previous extension applies only to items identical to previously approved items. Specific requirements for qualification by extension are available in reference (f), section 3.2.

3.1.4 **Qualification by Analysis:** Shock qualification by analysis is in general a very difficult thing to attain. It ordinarily applies only to items too large to test or to equipment foundations. "Too large to test" in this context means that the test item and the fixturing required to install it on the Large Floating Shock Platform (LFSP) weigh a total of more than 400,000 pounds. It can also mean that the test item and fixturing are too large to fit in a space roughly 45 feet long by 26 feet wide and 30 feet high. Exact dimensions are shown in reference (f) Figure 4.

a. If shock qualification by analysis is required for a SPAWAR item, the analysis shall be submitted to SUPSHIP, Colts Neck, New Jersey, via the SPAWAR Shock Coordinator for review and approval.

3.1.5 **Shock Test Approval Process**

The following shock test approval process is suggested:



3.2 Vibration

Ref: (a) MIL-STD-167 Mechanical Vibrations of Shipboard Equipment (Type 1 – Environmental and Type II – Internally Excited) of 1 May 74
(b) MIL-STD-167/2A Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting) Types III, IV and V (CONTROLLED DISTRIBUTION) of 12 May 92

3.2.1 Overview: Equipment destined for ship installation requires assessment for vibration. Reference (a) covers the requirements of Naval equipment including machinery as regards both internally excited vibrations and externally imposed vibrations. Mechanical vibrations of shipboard equipment are of three general categories: environment (Type I), internal excitation (Type II) and shipboard propulsion. The first two sources of vibration are covered in Reference (a) and the last is covered by Reference (b). Type I (environmental) vibration is in general the only one of concern to SPAWAR equipment. Appropriate requirements, as noted below, shall be included in acquisition documentation. Mast mounted antennas and associated systems shall be designed for a static load of 2.5 g (1.5 g over gravity) in vertical and transverse (athwartship and longitudinal) directions to compensate for the influence of rough weather.

3.2.2 Process: All equipment shall undergo, in each of three orthogonal axes, an exploratory vibration test to determine the presence of resonances, then a variable frequency vibration test followed by an endurance vibration test. The exploratory test consists of low amplitude vibration as specified in reference (a), paragraph 5.1.3.3.1. The variable frequency test consists of vibrating the equipment at the amplitudes shown in Table I of reference (a) for five minutes at each frequency. The endurance test consists of vibrating the equipment at its resonant frequency for a period of at least 2 hours at the amplitudes shown in Table I (Table II for mast mounted equipment) of reference (a). In the case of multiple resonances, the endurance test shall be performed at the frequencies chosen by the test engineer for a total of at least two hours. If no resonance is observed the endurance test shall be performed at the highest frequency determined by paragraph 5.1.3.3.4 of reference (a).

The requirements of references (a) and (b) should be tailored as appropriate for the equipment under consideration and the platform characteristics. For example, it is rarely necessary to perform vibration tests over the full 4 hertz to 50 hertz range which is the default in reference (a). The maximum frequency of interest is the propeller blade passing rate (maximum shaft rpm x number of propeller blades/60). Paragraph 5.1.3.3.4 of reference (a) describes how to determine the maximum frequency requirement of the vibration test.

3.3 Blast: Gun Blast, Missile Launch Overpressure, Nuclear Weapons

Ref: (a) OPNAVINST 9070.1
(b) OPNAVINST 3401.3A
(c) NAVSEAINST C3401.1
(d) MIL-STD-1399A (NAVY), Section 072.1, Interface Standard for Shipboard Systems, Blast Environment, Missile Exhaust
(e) MIL-STD-1399A (NAVY), Section 072.2, Interface Standard for Shipboard Systems, Blast Environment, Gun Muzzle
(f) MIL-STD-1399A (NAVY), Section 072.3A, Interface Standard for Shipboard Systems, Blast Environment, Nuclear Weapons

3.3.1 Overview: The operational environments that are addressed in reference (a) should be considered in the ship design process. Reference (b) assigns specific duties to all SYSCOMs, under the lead of NAVSEA. Reference (c), which is classified, establishes nuclear survivability criteria for all surface ships, including blast, thermal radiation, EMP and TREE. As discussed in references (d) and (e), the launching of ship's missiles and firing of ship's guns creates high localized overpressures, high energy debris, and noxious gases within the vicinity of the missile launching area and gun mount. The repetitive nature of this environment may cause significant and extensive damage to nearby equipment and structures. Appropriate requirements shall be delineated in acquisition documentation. A Blast IPT is formed by the procuring activity and includes SPAWAR 051-1, SPM and other key groups if the complexity of the new design or modification warrants the level of coordination otherwise the procuring activity will perform design selection and verification in close coordination with the Ship Program Manager (SPM).

The blast from nuclear weapons is discussed in reference (f) and is tailored for specific ships therefore the ship specifications will need to be referenced. The Blast IPT will select the specific protection parameters for overpressure and dynamic pressure. The Blast IPT will also provide the specific protection parameters for thermal pulse as required by current ship protection policy.

3.3.2 Process: The interface characteristics of the missile and gun blast environment consist of the following elements:

a. Temperature (see 5.2.1 of MIL-STD-1399, Sec 072.1).

b. Pressure (see 5.22).

c. Erosive debris (see 5.2.3).

d. Smoke (see 5.24).

e. Toxic gases (see 5.25).

These characteristics will be present on all ships with installed missile systems.

The interface characteristics of the gun blast environment consist of the following elements:

a. Overpressure (see 5.2.1 of MIL-STD-1399, Sec 072.2).

b. Shock (see 5.2.2).

c. Gun ejected debris (see 5.2.3).

d. Noxious gas products (see 5.2.4).

These characteristics will be present on all ships with installed guns to varying levels based upon where the system is installed. Appropriate requirements, based upon analysis and coordination with key parties, shall be delineated in acquisition documentation and verified by test. For nuclear blast protection design, the interface characteristics of the shipboard nuclear weapon air blast environment impose certain constraints on the design of topside ship structure and installed equipment exposed to this environment. Equipment that will be adversely affected by the nuclear blast environment shall be designed to withstand that environment. To the maximum extent practical, equipment and appurtenances that will be adversely affected by the nuclear blast environment shall be located in the interior of the ship structure rather than topside. This nuclear weapons blast requirement does not apply to non-combat ships with the exception of Underway Replenishment Station Ships.

Analysis and testing will need to be performed to ensure that the design requirements and overall operational performance can be met. A successful design analysis and performance test program will require close coordination between SPM, SPAWAR 051-1 and the procuring activity.

3.4 Green Water Loading

Ref: (a) MIL-HDBK-2036, Preparation of Electronic Equipment Specifications of 1 Nov 99

3.4.1 Overview: Greenwater loading applies to exterior or unsheltered equipment on ships or craft. Mobile equipment that may be placed on vehicles that are carried topside or in landing craft should be considered susceptible to backwash and greenwater loading.

3.4.2 Process: As defined in reference (a), equipment parts exposed to backwash and greenwater loading should show no mechanical or electrical damage when the mean greenwater load is 42 kilopascals (6.1 psi) for surface ships. This requirement, as defined in the ship class requirements, should be provided in acquisition documentation and verified by test.
Note: Each ship class has its own greenwater loading requirement. For example in aircraft carriers the standard is 11 PSI, however, in some forward areas of the ship, where antennas are located, the green water could be between 40-90 PSI.

4 Climatic Environments

4.1 Temperature

Ref: (a) MIL-HDBK-2036, Preparation of Electronic Equipment Specifications of 1 Nov 99
(b) MIL-STD-810F, Environmental Engineering Considerations and Laboratory Test of 1 Jan 00

4.1.1 Overview: Requirements for temperature, as defined in reference (a), should be as specified in acquisition documentation and verified by test. Temperature tests for equipment should be tailored in accordance with MIL-STD-810F, Method 501 (High Temperature), and MIL-STD-810F, Method 502 (Low Temperature).

4.1.2 Process: The specific test methods are contained in reference (b), Methods 501.4 and 502.4, and the specified criteria for equipment installed in controlled spaces should include consideration of failure of the environmental control system for 8 hours, that is, equipment should be suitable for exposure in an uncontrolled environment for 8 hours.

4.2 Humidity

Ref: (a) MIL-HDBK-2036, Preparation of Electronic Equipment Specifications of 1 Nov 99
(b) MIL-STD-810F, Environmental Engineering Considerations and Laboratory Tests of 1 Jan 00
(c) IEC 68-2-52, Test Kb, Salt Mist, Cyclic, NaCl solution of 1966

4.2.1 Overview: Requirements for humidity should be in accordance with the guidance of reference (a) and specified in reference (b), and as specified below.

4.2.2 Process: As defined in reference (b), equipment should be suitable for exposure in an uncontrolled environment for eight hours. Fully hardened equipment should maintain specified performance when subjected to 100 percent relative humidity. Humidity tests should be tailored in accordance with IEC 68-2-30 or MIL-STD-810, Method 507, to simulate shipping and storage conditions, and when applicable, installation in an uncontrolled environment. The temperature range in IEC 68-2-30 should be changed to "25EC to 55EC". Equipment not subjected to testing in accordance with IEC 68-2-30 or MIL-STD-810 should withstand 95 percent relative humidity, and humidity tests should be tailored in accordance with IEC 68-2-3, except the test period should be 21 days.

4.3 Stack Gases

Ref: (a) OPNAVINST 5100.23E OPNAVINST Navy Occupational Safety and Health (NAVOSH) Program Manual (NOTAL) of 5 Oct 00
(b) OPNAVINST 5100.19D Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat (NOTAL) of 14 Jan 94
(c) MIL-STD-810F, Method 518, Acidic Atmosphere of 1 Jan 00

4.3.1 Overview: The requirement, as delineated in MIL-STD-810F, Method 518, Acidic Atmosphere, applies for topside systems that are stored or operated in areas where acidic atmospheres exist, such as near the exhausts of any fuel-burning device, i.e. ship stack gases. Acidic atmospheres are of increasing concern, especially for materiel in the vicinity of industrial areas or near the exhausts of fuel burning devices. Examples of problems that could occur as a result of acidic atmosphere exposure are as follows. The list is not intended to be all-inclusive, and some of the examples may overlap.

a. Chemical attack of surface finishes and non-metallic materials.

b. Corrosion of metals.

c. Pitting of cement and optics.

4.3.2 Process: The process is delineated in reference (b) and presented herein. Two severity levels are defined (reference (c)). In view of the complexity of naturally occurring corrosion processes, no strict equivalencies with real exposure can be quoted. Use severity "a" below for simulating infrequent periods of exposure, or for exposure in areas of much lower acidity. Use severity "b" below to represent approximately ten years natural exposure in a moist, highly industrial area, or a shorter period in close proximity to vehicle exhaust systems, particularly ship funnel exhausts where the potential acidity is significantly higher.

a. Three Two-hour spraying periods requiring 22 hours storage after each.

b. Four Two-hour spraying periods requiring seven days storage after each.

Test configuration is an important element of the test, therefore correct usage of a configuration that is representative of its use on the topside is extremely important.

4.3.3 Testing: The test, in accordance with MIL-STD-810F, Method 518: For spraying, use a test solution containing 11.9mg (6 Pl) sulfuric acid (95-98%)/4 liters of solution and 8.8mg (6 Pl) nitric acid (68-71%)/4 liters solution in distilled or deionized water. This will produce a solution with a pH of 4.17 that is representative of some of the worst rain pH's recorded for rainfall in the eastern United States and other heavily industrialized areas with acidic emissions. Reference (c) provides information regarding the more common chemical environmental contaminants together with some consequent likely forms of corrosion that material could encounter.

WARNING: Strong acids are hazardous. The solution to be sprayed is harmful to people and clothing. Operators carrying out the test must take suitable precautions.

WARNING: Refer to the supplier's Material Safety Data Sheet (MSDS) or equivalent for health hazard data.

5 Structure Impacts

5.1 Weight and Moments

Ref: (a) NAVSEAINST 9096.5B, Weight Control Responsibilities During Detail Design and Construction of 7 Dec 87

5.1.1 Overview: The present program for weight and moment control was established in the 1960's after several ships were completed and found to be overweight resulting in gross deficiencies in list, trim, and stability. It is the policy of NAVSEA that the weights and moments of ships undergoing detail design and construction for new shipbuilding, conversion or major modernization be controlled to prevent unacceptable deterioration of the naval architectural and performance characteristics of the ship. The added weight of the C4ISR installation is assessed to determine the impact to ship super structure of load bearing members and stability of the ship.

5.1.2 Process: The IPT shall include appropriate weight control requirements and procedures in all ship acquisition, conversion, or modernization solicitations. Ensure procedural compliance by contactors. Maintain weight control of configuration change requests (ECPs, deviations). Institute appropriate contractual incentives for weight and vertical center of gravity control for all future shipbuilding contracts. Provide weight and moment information and stability requirements in Contract Modification adjudication to retain weight and moment accountability.

5.2 Weapon Cutouts

Ref: (a) NAVSEAINST 9700.1A, Pointing and Firing Zone Cutout, Blast Zone Cutout, and Radiation Hazard (RADHAZ) Zone Cutout Program for Surface Shipboards Systems of 9 Jan 90

5.2.1 Overview: The C4ISR equipment installation plans are reviewed to ensure that encroachment does not occur into weapon safety/operational cutouts as directed by reference (a).

5.2.2 Process: NAVSEA shall ensure ship contractual specifications and ship alteration documentation contain the requirement for identification, setting, testing and certification of pointing and firing cutout, blast and RADHAZ cutout mechanisms and computer program cutouts for all weapon delivery/launching systems. Ensure that all ship alternations that modify the ship's topside configuration contain the requirement to reassess pointing and firing, blast and RADHAZ cutout zone data, and computer program cutout data. NSWCDD is designated the Technical Direction Agent for Pointing and Firing Cutout zones, Blast and RADHAZ Cutout zones and shall develop and maintain that data for the life of the surface ship.

5.3 <u>Optical Blockage (Navigation Lights and Sights)</u>

Ref: (a) Commandant Instruction M16672.2D, Navigation Rules, International – Inland of 25 Mar 99

5.3.1 <u>Overview</u>: The plans of C4ISR installation are reviewed to ensure that the equipment does not block navigational lighting of the ship or lines of sight of the bridge and lookouts and meets the requirements of reference (a).

In addition, there are other navigation lights typically found on Naval vessels such as anchor lights, task lights, blinkers, aviation warning lights and contour lights that need to be considered, not just navigational lighting.

5.3.2 <u>Process</u>: An optical blockage analysis will need to be performed as part of the overall topside analysis. Coordination is required between the SPM, procuring activity, In-service Engineering Agency (ISEA) and planning yards.

From a total topside design perspective, there are numerous other non-antenna systems and functions, e. g. signal halyards, whistles, deck lighting (particularly aircraft carriers), lines of sight from the bridge, cameras, and lookout stations that occupy topside space, each having its own set of requirements for interference and coverage as identified in the ship specifications. All of these are considered when locating antennas.

5.4 Access Blockage

Ref: (a) Occupational Safety and Health Administration, Department of Labor, Regulations (Standards - 29 CFR) Part 1926.34 Subpart C - Means of egress

5.4.1 Overview: During installation of ship modernization equipment, it is important that egress via critical passages and access to systems not be hindered by the installation.

5.4.2 Process: The plans of C4ISR installation are reviewed to ensure that new or modified equipment, subsystems and systems do not block access/egress from a space during normal activity or during an emergency. Installations should not block vents, rotating/moving systems, or impair operational movement of personnel or equipment/systems to meet the requirements of reference (a). Any new requirement for an increase in the number of personnel occupying a space should be analyzed and evaluated to determine if the size and/or number of exits is satisfactory. Any new spaces or structures that are added for a system installation also need to meet these requirements based on the number of personnel required to operate and/or maintain the system. All exits are to be adequately marked.

6 Safety

Ref: (a) OPNAVINST 5100.23E OPNAVINST Navy Occupational Safety and Health (NAVOSH) Program Manual (NOTAL) of 5 Oct 00
(b) OPNAVINST 5100.19D Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat (NOTAL) of 14 Jan 94
(c) OPNAVINST 5100.24A Navy System Safety Program of 3 Oct 86
(d) SPAWARINST 5100.5C, Space and Naval Warfare Systems Command System Safety Program of 25 Nov 87
(e) MIL-STD-882D, Standard Practice for System Safety of 10 Feb 00

6.1 Overview: The references call out the total safety and occupational health program which includes all safety disciplines, such as systems safety, aviation safety, weapons/explosives safety and off-duty safety (recreation, public and motor vehicle), as well as occupational safety and health. Thus, the Navy Occupational Safety and Health (NAVOSH) Program is a major component of the total program. For the purposes of Topside Design, the Safety aspects of C4ISR installations will be considered and risk levels defined per MIL-STD-882D for afloat systems and personnel. The purpose of MIL-STD-882D is to outline and establish a System Safety Program or effort that is documented and that will consist of the appropriate and applicable elements or tasks so that the associated mishap risk of the system, equipment, etc., is identified, evaluated, and mitigated to an acceptable level, as is required by appropriate authority, laws, regulations and directives. The safety program or effort needs to be tailored in its scope and magnitude to be at the proper level in relationship to the system or equipment being evaluated and reviewed. C4ISR systems and equipments need to have appropriate safety programs or efforts established early in the design or development process so that any safety issues or discrepancies identified can be corrected or addressed so as to minimize the impact to the program or planned operational use of the system or equipment.

6.2 Process: The specific approach identified in MIL-STD-882 is identified below.

a. Documentation of the system safety approach. Document the developer's and program manager's approved system safety engineering approach. This documentation shall:

(1) Describe the program’s implementation using the requirements herein. Include identification of each hazard analysis and mishap risk assessment process used.

(2) Include information on system safety integration into the overall program structure.

(3) Define how hazards and residual mishap risk are communicated to and accepted by the appropriate risk acceptance authority (see 4.7) and how hazards and residual mishap risk will be tracked (see 4.8).

b. Identification of hazards. Identify hazards through a systematic hazard analysis process encompassing detailed analysis of system hardware and software, the environment (in which the system will exist), and the intended use or application. Consider and use historical hazard and mishap data, including lessons learned from other systems. Identification of hazards is a responsibility of all program members. During hazard identification, consider hazards that could occur over the system life cycle.

c. Assessment of mishap risk. Assess the severity and probability of the mishap risk associated with each identified hazard, i.e., determine the potential negative impact of the hazard on personnel, facilities, equipment, operations, the public, and the environment, as well as on the system itself. The tables in Appendix (A) are to be used unless otherwise specified.

d. Identification of mishap risk mitigation measures. Identify potential mishap risk mitigation alternatives and the expected effectiveness of each alternative or method. Mishap risk mitigation is an iterative process that culminates when the residual mishap risk has been reduced to a level acceptable to the appropriate authority. The system safety design order of precedence for mitigating identified hazards is:

(1) Eliminate hazards through design selection. If unable to eliminate an identified hazard, reduce the associated mishap risk to an acceptable level through design selection. MIL-STD-882D.

(2) Incorporate safety devices. If unable to eliminate the hazard through design selection, reduce the mishap risk to an acceptable level using protective safety features or devices.

(3) Provide warning devices. If safety devices do not adequately lower the mishap risk of the hazard, include a detection and warning system to alert personnel to the particular hazard.

(4) Develop procedures and training. Where it is impractical to eliminate hazards through design selection or to reduce the associated risk to an acceptable level with safety and warning devices, incorporate special procedures and training. Procedures may include the use of personal protective equipment. For hazards assigned Catastrophic or Critical mishap severity categories, avoid using warning, caution, or other written advisory as the only risk reduction method.

e. Reduction of mishap risk to an acceptable level. Reduce the mishap risk through a mitigation approach mutually agreed to by both the developer and the program manager. Communicate residual mishap risk and hazards to the associated test effort for verification.

f. Verification of mishap risk reduction. Verify the mishap risk reduction and mitigation through appropriate analysis, testing, or inspection. Document the determined residual mishap risk. Report all new hazards identified during testing to the program manager and the developer.

g. Review of hazards and acceptance of residual mishap risk by the appropriate authority. Notify the program manager of identified hazards and residual mishap risk. Unless otherwise specified, the suggested tables A-I through A-III of the appendix will be used to rank residual risk. The program manager shall ensure that remaining hazards and residual mishap risk are reviewed and accepted by the appropriate risk acceptance authority (ref. table A-IV). The appropriate risk acceptance authority will include the system user in the mishap risk review. The appropriate risk acceptance authority shall formally acknowledge and document acceptance of hazards and residual mishap risk.

h. Tracking of hazards, their closures, and residual mishap risk. Track hazards, their closure actions, and the residual mishap risk. Maintain a tracking system that includes hazards, their closure actions, and residual mishap risk throughout the system life cycle. The program manager shall keep the system user advised of the hazards and residual mishap risk.